Title of Invention

Lawnmower Rotary Cutting Apparatus and Grass Guide

Cross Reference to related Application

U.S. Patent 4,031,696, June 28, 1977, "Blade configuration for cordless lawnmower", Fleigle, Donald Earl.

U.S. Patent 4,052,789, Oct. 11, 1977, "Rotary cutting assembly", Ballas, George Charles Sr.

U.S. Patent 4,064,680, December 27, 1977, "Cordless twin blade lawnmower construction", Fleigle, Donald Earl.

U.S. Patent 4,987,729, Jan. 29 1991, "Solar powered mower", Paytas, Anthony R.

U.S. Patent 5,007,234, Apr. 16, 1991, "Automatic self-guiding lawn mower and mowing method", Shurman etc.

U.S. Patent 5,261,217, Nov. 16, 1993, "Cutting Head for lawnmower", Allen, Frank R.

U.S. Patent 5,572,856, Nov. 12, 1996, "Remotely controlled lawn mower", Ku, Chingyu J.

U.S. Patent 5,761,892, June 9, 1998, "Rotary Mower", Quiroga, Osvaldo R.

U.S. Patent 6,427,429, Aug. 6, 2002, "Multiple String Mower", Brabenec, William.

Field of the Invention

The present invention relates to a rotary cutting apparatus and grass guide used for mowing lawns. More particularly, it relates to a rotary cutting apparatus for mowing lawns using a plurality of small blades with their plane of rotation rotated between 1^0 and 90^0 from the horizontal plane of rotation. The rotation of the small blades from the horizontal plane of rotation working in conjunction with the grass guide results in a more efficient cutting design. Additionally, the utilization of a plurality of small blades results in a significant savings in required rotational kinetic energy due to the large reduction in mass of the plurality of blades from that of a conventional lawnmower blade. Consequently, a lawnmower utilizing this rotary cutting apparatus and grass guide will have a smaller, quieter, lighter and less powerful motor or motors. This results in a lawnmower, which is smaller, quieter, lighter and easier to operate and store than a conventional lawnmower. This design improves the operating safety by using a plurality of small blades operating with significantly less power than a conventional lawnmower. These improvements in safety, quietness, lightness and smallness would benefit both user-operated lawnmowers and self-guiding lawnmowers.

Background of the Invention

Most present day lawnmowers cut the lawn using one large blade rotating in a substantially horizontal plane of rotation. Additionally, most lawnmowers have some type of blade height adjustment. This adjustment can be used to reduce the power required to cut the lawn by raising the blade. However, once a blade height is selected the height and thickness of the lawn and the velocity in which the mower is moved through the lawn determine the blade's cutting area and amount of power required by the lawnmower. To accommodate the wide mixture of grass heights and thicknesses while providing for adequate speed of forward movement to satisfy the user, most lawnmowers have internal combustion engines of significant horsepower. Electric motors of equal horsepower are used, but an adequate power source to drive the electric motor becomes the problem. For instance, the batteries required to supply enough power for an adequate mowing time are prohibitive in size, weight and expense. Similarly, the typical home 20-amp circuit restricts power supplied by a power cord. A power cord also restricts ease of movement.

The combination of a single large blade and a powerful internal combustion engine or electric motor also presents a safety hazard since the blade is capable of cutting with significant force. A further drawback is the relatively large size and weight of lawnmowers utilizing a powerful internal combustion engine or large electric motor, which reduces the ease of lawnmower operation and storage.

In U.S. Pat. No. 5,761,892, Quiroga discloses a rotary blade for a rotary lawnmower that provides an equivalent cut with substantial reduction in necessary driving power. In the present invention different techniques are used to reduce the necessary driving power.

Summary of Invention

This invention discloses both a rotary cutting apparatus, which uses a plurality of small blades with their plane of rotation rotated between 1^0 and 90^0 from the horizontal plane of rotation and a grass guide. The rotation of the small blades from the horizontal plane of rotation working in conjunction with the grass guide reduces the size of the blade's cutting area. This is accomplished by the grass guide bending the incoming uncut grass such that the uncut grass is only cut when the blades are in the lower portion of their plane of rotation. Therefore, the maximum amount of power required is reduced by this design. This is in contrast to a conventional lawnmower in which the power requirements are determined mostly by the velocity in which a mower is moved through the lawn. Additionally, by bending the grass, the grass guide constrains the movement of the grass, thereby making it easier for the plurality of blades to cut the grass. Another advantage comes from the significant savings in required rotational kinetic energy due to the large reduction in mass of the plurality of small blades from that of a single large blade. By limiting the amount of energy required, the horsepower required by a lawnmower using the disclosed rotary cutting apparatus and grass guide is significantly reduced from that of a conventional lawnmower. This reduction of required power allows for a smaller, lighter and less powerful motor or motors. The preferred power source for

portability would be a rechargeable battery or combination of solar panels and rechargeable battery, but a corded source can be used. The power source would then provide power to a plurality of electric motors. However, a single electric motor or a conventional internal combustion engine driving a plurality of small blades can be substituted. New, alternative power sources may also be substituted. For instance, in a few years fuel cells may become the preferred power source.

Use of an electric motor or motors would result in additional power savings since each motor would independently draw additional current only as its load increased. The reduced weight and distribution of motor volume resulting from the use of a plurality of small motors is a further advantage. Since the cutting speed of a rotary blade is a function of both the rotations per minute (RPM) and the distance from the axis of rotation, the RPM of a plurality of small blades must be increased to be similar to the cutting speed of a single large blade. This increase in RPM has the advantage of providing greater cutting frequency. Through the use of a plurality of small high RPM motors this increase in RPM is easily obtained. However, increasing the RPM of a plurality of small blades using a single electric motor or a conventional internal combustion engine may require additional gearing mechanisms. Using a plurality of small electric motors has the additional advantage that each motor can be connected directly to the blade's driveshaft and no separate mechanical drive mechanism would be required as with a single motor system.

The use of a smaller lighter motor or motors results in a smaller, quieter, lighter lawnmower, which is easier to operate and store. Another advantage of this design is that

the use of a plurality of small blades operating with significantly less power than a conventional lawnmower, improves operating safety. These improvements in safety, lightness and smallness would benefit both user-operated lawnmowers and self-guiding lawnmowers. Since the total mass and volume of the plurality of small blades will be significantly less than one large blade, new blade designs and different and possibly more expensive construction materials can be used. Alternatively, a string-like or wire cutting members can be substituted for the blades. An environmental advantage of using the preferred power source of a rechargeable battery or combination of solar panels and rechargeable battery is that the mower would produce zero emissions and would not require any gas or oil. Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiment.

Brief Description of the Several Views of the Drawing

The present invention and its advantages will become more fully understood by way of the following description and drawings. The drawings are for illustration only, and thus are not limitative of the present invention.

FIG. 1 is a side view of a lawnmower utilizing the rotary cutting apparatus and grass guide in accordance with the preferred embodiment of the present invention.

FIG. 2A is a top view of the blade's cutting area as a lawnmower is moved forward at a velocity v_1 and rotating at RPM_1 for a single blade of the preferred embodiment of the present invention.

FIG. 2B is a top view of the blade's cutting area as a lawnmower is moved forward at a velocity v_2 and rotating at RPM_2 for a single blade of the preferred embodiment of the present invention.

FIG. 3A is a top view of the blade's cutting area as a lawnmower is moved forward at a velocity v_1 and rotating at RPM_1 for the blade of a conventional lawnmower.

FIG. 3B is a top view of the blade's cutting area as a lawnmower is moved forward at a velocity v_2 and rotating at RPM_2 for the blade of a conventional lawnmower.

FIG. 4 is a front view of a lawnmower utilizing the rotary cutting apparatus and grass guide in accordance with the preferred embodiment of the present invention.

Detailed Description of the Invention

The present invention relates to a lawnmower rotary cutting apparatus using a plurality of small blades with their plane of rotation rotated between 1^0 and 90^0 from the horizontal plane of rotation. FIG. 1 illustrates a blade 1 rotated from the horizontal plane of rotation. This figure shows a small electric motor 2, wheels 3, handle 4 and outer

housing 5. The incoming uncut grass is bent by the grass guide 6 such that the uncut grass is only cut when the blades are in the lower portion of their plane of rotation. FIG. 2A illustrates the cutting area 7 of a single blade at a forward velocity v_1 and rotating at RPM_1 for the preferred embodiment of the present invention. FIG. 2B shows the blade's cutting area 8 as a lawnmower is moved forward at a velocity v_2 and rotating at RPM_2 for a single blade of the preferred embodiment of the present invention. FIG. 3A shows the blade's cutting area 9 as a conventional lawnmower is moved forward at velocities v_1 and rotating at RPM_1. FIG. 3B shows the blade's cutting area 10 as a conventional lawnmower is moved forward at velocities v_2 and rotating at RPM_2. RPM_2 is set to have a smaller value than RPM_1 and is used to indicate times when the RPM of the blade is reduced due to increase loading from the grass becoming thicker and taller. Forward velocity v_2 is set to have a larger value than v_1 and is used to show the effect of greater forward velocity. FIGS 2A and 2B illustrate that the grass guide and the angle of the blade from the horizontal plane of rotation reduce the blade's cutting area. This means that in areas where the grass becomes too thick and tall or when the forward velocity becomes too great some portions of the grass will remain uncut. In other words, this design limits the blade's cutting area; consequently, the maximum amount of power required is limited by this design. This is in contrast to a conventional lawnmower in which the blades cutting area is not limited as shown in FIGS 3A and 3B. With a conventional mower, in areas where the grass becomes too thick and tall or when the forward velocity becomes too great the mower will stall.

In addition, by bending the grass, the grass guide constrains the movement of the grass, thereby making it easier for the plurality of blades to cut the grass. This combination of reducing the blade's cutting area and constraining the movement of the grass results in a more efficient cutting design than that of a conventional mower.

FIG. 4 illustrates a plurality of small blades 1, plurality of small motors 2, wheels 3, handle 4, outer housing 5 and grass guide 6. This invention uses small blades located at the cutting region of the bent and constrained grass. The plurality of blades provides for an adequate cutting width. The rotational kinetic energy of a blade is its ability to do work because of its motion and is usually expressed by the equation

$$\frac{1}{2} I\omega^2, \tag{1}$$

where I is the moment of inertia of the blade and ω is the angular velocity. For a rectangular blade with its axis through the center,

$$I = \frac{m}{12}\left(l^2 + w^2 + h^2\right), \tag{2}$$

where l is the length, w is the width, h is the height or thickness and m is the mass of the blade. The mass of the blade is obtained by multiplying the density of the blade by the blade volume. The total rotational kinetic energy required by a plurality of small blades is the sum of the rotational kinetic energy required for each small blade. Since the cutting

speed of a rotary blade is a function of both the angular velocity and the distance from the axis of rotation, the angular velocity of the plurality of small blades must be increased to be similar to the cutting speed of a single large blade. This increase in angular velocity has the additional advantage of providing greater cutting frequency. Using small high RPM electric motors the angular velocity of a plurality of small blades can be easily increased; however, increasing the angular velocity of a plurality of small blades using a single electric motor or a conventional internal combustion engine may require a gearing mechanism. Using a plurality of small electric motors has the additional advantage that each motor can be connected directly to the blade's driveshaft and no separate mechanical drive mechanism would be required as with a single motor system. Use of an electric motor or motors results in additional power savings since each motor would independently draw additional current only as its load increased. The reduced weight and distribution of volume resulting from the use of a plurality of small motors is a further advantage.

For the disclosed invention the angular velocity ω, will be increased, while the length of the blades will be decreased from that of a conventional lawnmower. Consequently, these two squared terms in Equations (1) and (2) will approximately offset each other. The largest difference between this design and a conventional mower is the mass of the blades. By significantly decreasing the mass by use of the plurality of small blades the rotational kinetic energy of the disclosed invention is significantly reduced from that of a conventional mower. An experimental apparatus was built which demonstrated this significant reduction in required rotational kinetic energy.

New small blade designs can further reduce the power requirements. For instance, the blade can be designed aerodynamically to have very little air resistance. Since the total mass and volume of the plurality of small blades will be significantly less than one large blade, different and possibly more expensive construction materials can be used. Alternatively, a string-like or wire cutting member can be substituted.

An additional advantage of this design is that the use of a plurality of small blades operating with significantly less power than a conventional lawnmower improves operating safety. Another advantage is that the use of a smaller lighter motor or motors results in a smaller, quieter and lighter lawnmower, which is easier to operate and store. An environmental advantage of using the preferred power source of a rechargeable battery or combination of solar panels and rechargeable battery is that the mower would produce zero emissions and would not require any gas or oil. These improvements in safety, lightness, quietness and smallness would benefit both user-operated lawnmowers and self-guiding lawnmowers.